REMARKS

This application has been carefully reviewed in light of the Office Action mailed on December 13, 2002. Claims 22 and 29 have been amended. Attached hereto is a marked-up version of the changes made captioned "APPENDIX A." Claims 22-35 are pending in this application. Reconsideration of the above-referenced application in light of the amendments and following remarks is requested.

Claims 22-35 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Chiang et al. (U.S. Patent No. 5,739,579) ("Chiang") in view of Moslehi (U.S. Patent No. 6,016,000). Reconsideration is respectfully requested.

The present invention provides an interconnect structure utilizing a heat-radiating layer comprising aluminum nitride in an interconnect structure. Independent claims 22 and 29 have been amended to emphasize this important feature.

Amended claim 22 of the present invention positively recites a method of forming a copper interconnect structure, comprising the steps of ". . . . forming a heat-radiating layer on an upper surface portion of said copper conductor, said heat-radiating layer comprising a continuous layer of aluminum nitride passifying said upper surface portion of said copper conductor." Support is found in Applicant's specification page 13, lines 10-28.

Similarly, amended claim 29 recites a method of forming a copper interconnect structure comprising the steps of "forming a heat-radiating layer comprising aluminum nitride on an upper surface portion of said conductor, said aluminum nitride layer providing a heat dissipating path for said conductor." Support is found in Applicant's specification page 13, lines 10-28.

The subject matter of independent claims 22 and 29 is not obvious over Chiang in view of Moslehi. The cited art fails to teach or suggest a method of forming a copper interconnect structure with a "heat-radiating layer" comprising aluminum nitride.

Chiang teaches forming a "silicon oxynitride passivation layer 80" over a portion of a contact plug 61 and providing a titanium nitride barrier layer 60 on the sidewalls and bottom of the contact plug 61, (Col. 8, lines 10-68, Col. 9, lines 49-50) (emphasis added). Chiang is void of any discussion pertaining to forming a heat-radiating layer, much less an aluminum nitride passivation layer.

The Office Action further asserts that, "it would have been obvious . . . to form the passivation layer of aluminum nitride as Moslehi teaches in order to form a passivation layer that has the advantage of high thermal conductivity." (Office Action, pg. 3). Applicant respectfully disagrees.

Moslehi teaches a "free-space ILD/IMD structure . . . [thereby eliminating] the need for the use of diffusion barrier layers to encapsulate the metallization structure at each interconnect level." (Col. 8, lines 25-31). Thus, "copper can be deposited directly on the patterned structure without a need for a diffusion barrier layer." (Col. 12, lines 26-28) (emphasis added).

There is no motivation to combine Chiang and Moslehi. The top passivation layer of Moslehi is used to hermetically seal the interconnect structure. Moslehi's top passivation layer comprises three different layers: silicon dioxide, silicon nitride or silicon oxynitride, and at least a 5000 A° thick layer of insulating material such as aluminum nitride (Col. 15, lines 2-12). Moslehi does not teach or suggest forming a top passivation layer so that it is a heat-radiating layer. Moslehi teaches that "a helium-filled free-space medium . . . provides a much superior heat transfer medium." (Col. 15, lines 45-47). The presence of the ILD/IMD dielectric free-space region facilitates superior heat transfer and not the top passivation layer itself.

Further still, the cited references are directed to solving different problems. Chiang is directed to methods of providing a structure that can utilize copper interconnects. Chiang provides a structure that encapsulates copper 61 with barrier layers 60 such that the copper 61 does not diffuse out into the semiconductor device. Chiang

teaches that in the prior art, copper was not used as an interconnect metal because it possessed a relatively large diffusion coefficient into silicon dioxide and silicon (Col. 2., lines 48-52). Further, that "[c]opper interconnects should be encapsulated by at least one diffusion barrier to prevent diffusion into the silicon dioxide layer." (Col. 2, lines 54-56) (emphasis added).

Conversely, Moslehi is directed to providing methods of forming a structure that does not use barrier layers. In fact, Moslehi teaches that "all via-level barrier layers can be eliminated." (Col. 7, lines 48-53).

Even assuming arguendo, that the cited references are combinable, one still would not achieve the methods of Applicant's invention. Moslehi is directed only to the methods of forming multi-level interconnect structures. The teachings of Moslehi are not applicable to a single copper interconnect structure. In fact, Moslehi's structure will not work with a single copper interconnect structure since multiple levels are needed to form the ILD/IMD free-space dielectric regions.

In view of the above, each of the presently pending claims in this application is believed to be in immediate condition for allowance. Accordingly, the Examiner is respectfully requested to withdraw the outstanding rejection of the claims and to pass this application to issue.

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Respectfully submitted,

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APPENDIX A

22. A method of forming a copper interconnect structure providing electrical connection to a substrate, comprising the steps of:

forming a first contact opening into a first insulating layer of said substrate;

forming a conductive plug in said first contact opening;

forming a second insulating layer over said conductive plug and said first insulating layer;

forming a second contact opening in said second insulating layer;

forming a barrier layer in said second contact opening;

forming a copper conductor over said barrier layer; and

forming [an aluminum nitride layer] <u>a heat-radiating layer</u> on an upper surface portion of said copper conductor, said <u>heat-radiating layer comprising a continuous layer of</u> aluminum nitride [layer] passifying said upper surface portion of said copper conductor.

29. A method of forming an interconnect structure providing electrical connection in a semiconductor device comprising:

forming a contact opening in an insulating layer of said device;

depositing a conductor within said contact opening; and

forming a heat-radiating layer comprising [an] aluminum nitride [layer] on an upper surface portion of said conductor, said aluminum nitride layer providing a heat dissipating path for said conductor.